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Plasma tubes becoming collimated as a result of MHD pumping[1]

G.S. YUN[2], P.M. BELLAN, Caltech — Long collimated magnetized plasma tubes commonly occur in nature, ranging from solar coronal loops (10^{7-8} m) to astrophysical jets (10^{15-22} m). Plasma jets produced by the Caltech planar spheromak gun develop structures bearing a striking resemblance to these natural plasma tubes. We report detailed new experimental measurements[†] of gun-produced plasma jets that support a recently-proposed MHD pumping model[‡] as a universal collimation mechanism. Time- and space-resolved spectroscopic measurements show (i) suprathermal flow (30–50 km/s), (ii) large density amplification from 10^{17} to 10^{22-23} m^{-3} in an Alfvénic time scale, and (iii) flow slowing down and mass accumulation at the jet front. High-speed camera imaging shows that the collimation occurs at the jet front. These observations are consistent with the MHD pumping model which predicts (i) magnetic pumping of plasma particles from a high-density source region into a flux tube and (ii) tube collimation if the flow slows down leading to accumulation of mass and thus concentrating the azimuthal magnetic flux frozen in the mass flow (i.e., increasing the pinch force). [†]G. S. Yun, PhD thesis (2007) [‡]P. M. Bellan, Phys. Plasmas 10(2), 1999 (2003).

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